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"CONSERVATION OF WILD LIFE THROUGH EDUCATION"

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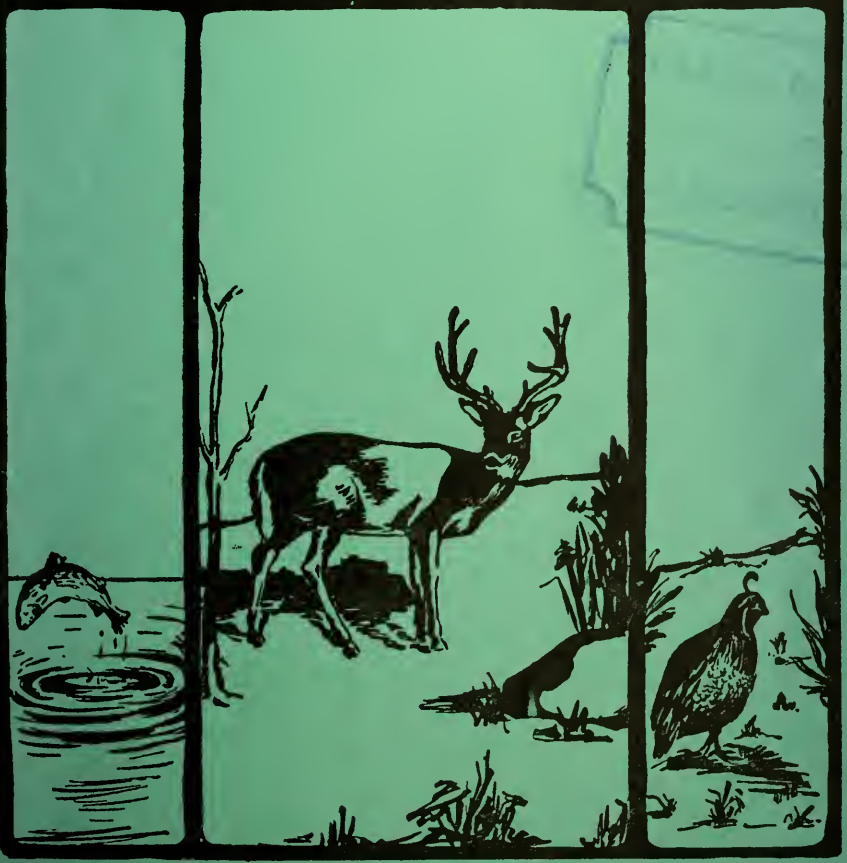

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STUDIES ON THE CONDITION OF CALIFORNIA MULE DEER AT SEQUOIA NATIONAL PARK [1]

By Joseph S. Dixon
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And
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The California mule deer, *Odocoileus hemionus californicus,* found in the Giant Forest area of Sequoia National Park, has increased under the protection of the National Park Service to such an extent that a problem of over utilization of browse has arisen on some species of plants. To investigate this, the senior author has over a period of years studied a number of small grazing plot areas fenced at critical points of the Giant Forest region. During the past several years trapping and removal of the surplus deer has been conducted on their winter range in the vicinity of Hospital Rock. The animals thus trapped have been taken out of the park. This live trapping of deer on winter range gave temporary relief. However, the deer continued to increase and there was still over utilization of the range in 1944. Concurrent with this problem, disease and parasites became more evident and upon the recommendation of Superintendent John R. White and of the Regional Office of the National Park Service, the California Fish and Game Commission and the Secretary of the Interior in 1943 authorized removal of not more than 40 additional deer from the Sequoia and Kings Canyon National Park areas.

This created special opportunity to study certain deer that were apparently suffering from disease and parasites on the winter range along the lower portions of the North and Middle Forks of the Kaweah River inside Sequoia National Park. Since it was obvious that a better knowledge of disease and parasites of deer in the above area would assist not only the National Park Service but also the Fish and Wildlife Service and the California Division of Fish and Game in their deer management program, these three agencies collaborated in the investigation. As a result of this cooperative effort, Superintendent John R. White and Ranger Clarence Fry of the National Park Service, Dr. Carlton M. Herman and Donald D. McLean of the California Division of Fish and Game, and Joseph S. Dixon of the United States Fish and Wildlife Service all worked together on the problem.

Field Observations

A field study made by the members of the party March 21 to March 24, 1944, showed that the general condition of both the deer and the forage on the winter range at the end of the winter was relatively good. A

[1] Submitted for publication August, 1944. Photographs by Joseph S. Dixon. Map drawn by Clarence Elliger.

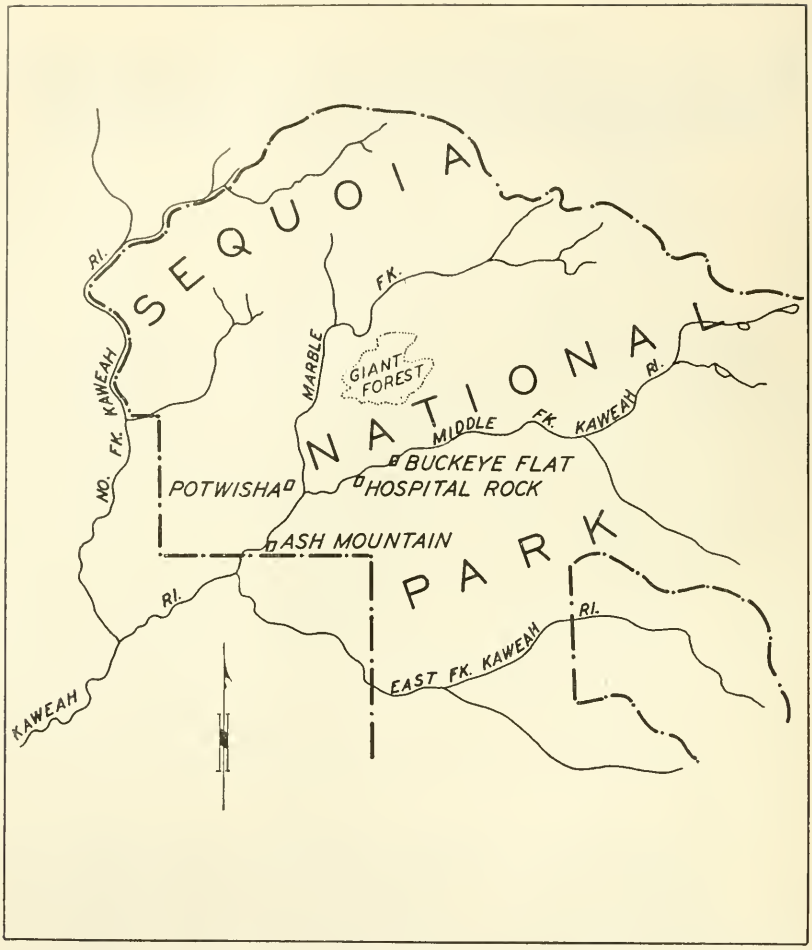

FIG. 1. Southwest corner of Sequoia National Park in which deer studies were made.

careful survey showed that the deer were well scattered in small groups of from 6 to 20 individuals on the warm south-facing slopes at altitudes between 1,700 and 3,000 feet in the blue oak belt, where a fair growth of green natural grasses and herbage was present. Above 3,100 feet the oaks had not leafed out and grass was just coming up so that the deer were scarce. On the lower slopes, as at Potwisha, Hospital Rock and Buckeye Flat, at an elevation of around 2,000 feet, the deer were found well distributed and feeding largely on succulent green grasses on the open hillsides. (See Fig. 2.)

During the middle of the bright, warm, spring days the deer were found bedded down in the shade of leafy buckeye trees. We found, at this time, that some pregnant does repeatedly stood on their hind legs and made special effort to reach up into the trees for the green leaves of this tree which chemical analysis has shown to be rich in bone building calcium.

Fig. 2. Does at Potwisha, March 23, 1944.

Two natural deer licks were examined along the North Fork of the Kaweah between Yucca Creek and Cow Creek. Both licks were in solid clay banks, not at springs or water holes. The first lick was below the road and a well worn deer trail led to it. The substance eaten was a whitish clay-like material which we found had a slightly salty taste. The other lick was in a vertical bank on the upper side of the road about one-quarter of a mile below Cow Creek. Here a definite hole about 15 inches across and 8 inches deep had been eaten out by the deer. Many deer tracks marked the locality and hoof-marks above the cavity showed that some deer had tried to paw out the material. Calcium and magnesium are believed to be the minerals sought in these natural licks. No analysis of the material was made and further study is desirable to determine the chemicals involved.

The evidence of need for supplemental minerals was found on the North Fork where deer congregated just below the west boundary patrol cabin. Here certain yerba santa bushes, which had been growing vigorously on a dirt fill below the road, had been almost defoliated and severely pruned by the over-browsing of the deer. (See Fig. 3.) Plants of vigorous growth were chosen by the deer and it is thought from the deer tracks that perhaps mineral contents plus availability may have been the reasons why certain bushes were so heavily browsed.

Poor condition of deer in this area in the past often has been attributed to artificial food such as cigarettes, chewing gum, candy, and camp wastes fed by Park visitors at Giant Forest. On March 23d and 25th, 65 and 67 deer respectively were examined with the aid of binoculars, particularly at the camp sites at Potwisha, Hospital Rock, and Buckeye Flat which are at an altitude of approximately 2,000 feet. Four of

FIG. 3. Yerba santa shrub over-browsed by deer.

these deer were found to be decrepit and undoubtedly suffering from disease. On March 24th, 178 deer on the North Fork of the Kaweah all appeared to be healthy.

Many of the deer observed on the Middle Fork showed evidence of heavy tick infestations (Fig. 4). As a group these deer were in poorer condition than those on the North Fork. At least two deer showed evidence of disease of the eye. This was demonstrated by the presence of a watery discharge and a tendency to keep the eyes closed much of the time. The condition was readily observed with the aid of binoculars. One of these animals (Deer 3-44) was collected for autopsy. Two other deer were observed to be thin, with scraggly coats and evidence of heavy tick infestations; one deer (Deer 4-44) was collected for autopsy.

Autopsy Findings

Examination of Deer 3-44 (March 23, 1944), adult female, taken near Hospital Rock. Stomach contents, not quite a full gallon, contained a large amount of browse, chiefly buckeye and mountain mahogany. About 75 per cent of this freshly eaten food in the first stomach had

FIG. 4. Doe and yearling showing evidence of heavy tick infestation.

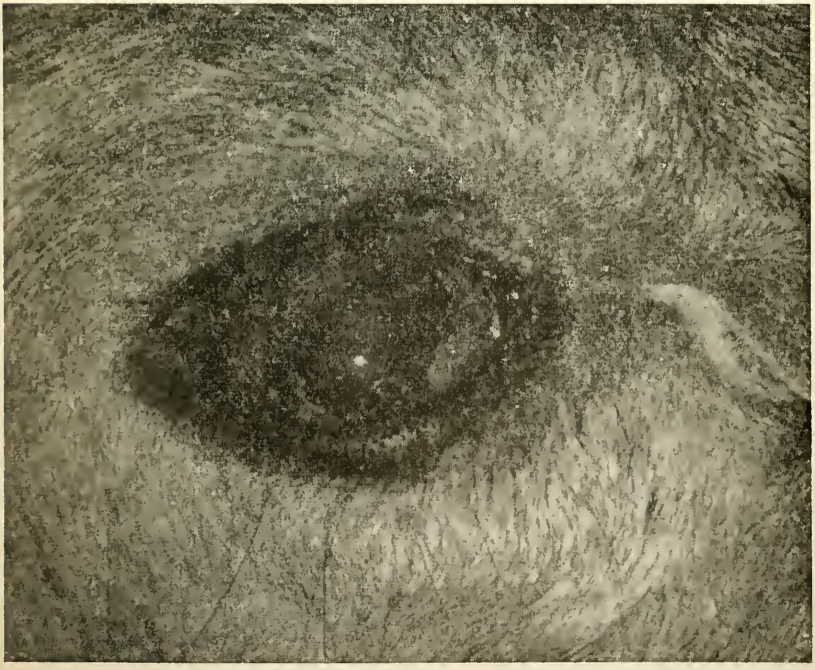

FIG. 5. Close-up of right eye of deer infected with eyeworms.

been nipped off roughly in pieces often $\frac{1}{4}$ to $\frac{3}{8}$ of an inch in length. Buds and flowers of the western redbud (*Cercis occidentalis*) constituted nearly 10 per cent of this doe's stomach content. Yerba santa and a little *Ceanothus cuneatus* foliage also had been eaten by this doe.

This deer was collected because observation showed the right eye to be partially shut. Examination at autopsy revealed both eyes to be infected with actively moving small round worms. Thirty-one of these worms (*Thelazia californiensis*) were collected from the left eye and 37 from the right eye. Although inflammation in this instance had been easily detected in the living deer with the aid of 7-power binoculars, her vision did not seem to be, as yet, seriously impaired. An opaque, bluish film was beginning to spread over the right eye and a whitish opaque area was developing (Fig. 5).

These worms occur on the surface of the eyeball. The vast majority of them remained hidden under the eyelid and were revealed only when the eyelid was artificially raised (Fig. 6). Their great activity made photography difficult.

Thelazia californiensis has been reported in the past from deer in this locality by Oberhansley (1940) in equally heavy concentrations, and

FIG. 6. Deer infected with *T. californiensis*. Note that most of the worms are under the eye lid.

from deer elsewhere in California by Herman (1944). It has been reported from dogs in many parts of the State and from several other animals as well as man. Such large numbers, however, have been observed only in the eyes of deer from Sequoia Park.

The senior author, on December 20, 1929, found and photographed (Dixon, 1934) a spike buck near this same locality which had both eyes badly inflamed and nearly closed with yellow pus (Fig. 7). From the work done on eyeworms by Oberhansley at Sequoia and from our present findings, it seems logical to conclude that this buck also suffered from an infection of *Thelazia* although not recognized as such at the time.

Ectoparasites were quite numerous on this doe. A careful examination was made in an effort to collect all of them. A number of larval mites, or chiggers (*Eutrombicula alfreddugesi*)—hardly larger than a pin-point and of an orange-red color—were found sucking blood on the skin of the back. Of several species of ticks, totaling 412 individuals, collected from this one doe, *Dermacentor occidentalis* was the most numerous. Two species of louse flies (*Hippoboscidae*) were found, chiefly in the groins. This doe harbored a total of 1,350 of these flies. There was also a single specimen of a blood-sucking louse.

Internally the animal seemed to be in fair condition. Three bot fly larvae were found in the upper trachea. Eleven cysticerci (bladderworm stage of tapeworms) were found on the omentum and a single tapeworm cyst was found on the lungs. The adults of these tapeworms occur in the intestine of a number of carnivores which feed on deer. There are no authentic reports of their occurrence in man.

Examination of Deer 4-44 (March 25, 1944), three year old male, taken near Buckeye Flat. Stomach contents watery, completely filling

FIG. 7. Spike buck at Hospital Rock, December 29, 1929. Condition of eyes possibly due to severe infection with *T. californiensis*.

a one-gallon bucket, consisted mainly of freshly eaten green grasses. The remains of a recently eaten last year's fruit of a California buckeye was also present in the stomach.

This deer was collected because observation showed it to be in poor condition and emaciated. There were many bare patches without hair on the neck. The animal seemed to be malnourished. No worms were present in either eye.

Ectoparasites were much less numerous than on the previous doe. With careful examination we were able to collect only 281 louse flies, 227 ticks and a single biting louse. No mites were observed.

Internally the animal was found to be in very poor condition. Five bot fly larvae were obtained from the nasal passages and throat. The chief finding was an extensive enteritis involving the abomasum (fourth stomach) and the entire intestinal tract. There was evidence of an old lung infection and enlargement of the ventricles of the heart, with hemorrhages in the heart muscles. The kidneys also were inflamed. In the field it was at first thought that the condition of the lungs might have been involved with the pathological findings of the other organs. No intestinal parasites were found in examination of the lumen of the intestines or in washings of the contents. However, some of the mucous from the upper intestines was placed in normal saline with added 2 per cent dichromate solution and examined several days later in the laboratory. At this subsequent examination numerous nematode larvae were observed. No further identification of this material was made because no adults were collected. Deer are known to be infected with several species of small stomach and intestinal worms which could easily have been the cause of the inflammation found in the intestinal tract. These worms feed on the blood of the animal. Loss of blood plus a toxicity produced by these worms could readily account for this buck's poor condition.

Discussion

The deer on the North Fork of the Kaweah River were definitely in much better condition than those observed on the Middle Fork. Several hypotheses can be proposed to account for this fact.

The deer in the areas on the Middle Fork have, over a period of years, come more and more to look to the tourists of the park for part of their food. This fact has tended to keep the deer in close proximity to the camps for, when approached, these animals circle back to the same spots. This concentration causes over-browsing in the immediate areas and constant grazing on limited areas. The life cycles of the stomach and intestinal worms are direct and closely tied up with grazing by the animals. Eggs of the worms are deposited with the fecal droppings of the infected animals and develop in the soil. Immature stages of the worms crawl onto blades of grass and are eaten by the deer along with its food. Thus the infections are constantly being built up to a peak. It appears that the intensity of these infections is directly proportional to the amount of grazing done by the deer and the recurrent use of the same pastures by infected deer.

The preferred species of browse, such as snow brush and bitter cherry, have been depleted more and more in the area and in many cases actually killed by over-browsing. The deer are forced to utilize the

meadows for forage. This builds up a vicious circle of reinfcetion. This relationship is particularly evident on the summer range at Giant Forest.

As well as tending to increase the worm burden, this sequence of events—the shifting to grass forage—undoubtedly tends to reduce the nutritional values of their total diet. Lack of mobility of the resident deer population in these areas seems to be the chief cause of present conditions.

The method of transmission of the eyeworms is not known. At present no reason can be suggested to explain the heavier infections with this worm in the deer at Sequoia than has, as yet, been observed elsewhere. It is hoped that further work now in progress will clarify some of these points.

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THE "BALLOON" TYPE OTTER TRAWL FOR ROCKFISHES [1]

By W. L. Scofield
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California Division of Fish and Game

A recent modification of fishing gear has had an immediate effect upon the fresh fish markets of the central part of the State. The flatfish otter trawl has been adapted to supplying the California markets with rockfish. This development has resulted from the abnormal conditions during war-time; and a brief summary of the background will help to explain what is happening in the "rock cod" fishery.

The so-called "rock cods," or more properly the rockfishes, include about fifty species of the genus *Sebastodes* (family *Scorpaenidae*), which are found in fair abundance nearly everywhere along the California coast. This group has been burdened with almost as many common names as there are species in the prolific genus. The best known kinds in our markets are variously known as bocaccio, salmon grouper, chili-pepper, Chinafish, and red snapper—to name but a few.

In normal times the volume of the California catch of rockfish has compared favorably with that of salmon, barracuda, or yellowtail. However, the importance of rockfish in our markets was greater than would be indicated by the number of pounds landed because these fish have served as a "filler," and could be depended upon to supply the demand for fresh fish during the off-seasons when more popular species were not plentiful. All along the coast of the State, periods of fish scarcity could be bridged by a scattered fleet of small boats fishing set-lines and hand-lines for rockfish. Prices to the fishermen varied widely, but during the winter and slack seasons for other species, the price rose sufficiently to support a small-boat fishery made up of but a few boats out of each port, but altogether making a substantial total.

With the entrance of our country into the war, many of the larger fishing boats were taken over for Government service. Fishing was curtailed by military restrictions; and there was a scarcity of certain fishing materials, as well as a manpower shortage. At the same time, there was an increased demand for fresh fish due to purchases by western army camps and to meat shortages throughout the country. The fishing industry struggled to maintain normal production, and to increase the supply of those varieties most desired by Federal purchasing agents; but the catch of rockfish sagged.

The Office of Price Administration then set the ceiling price for California rockfish so low that our fishermen, handicapped by increased operating costs, could not meet this new obstacle; so they turned to higher-priced fishes, while the runs were on; and practically ceased rockfish set lining. Rockfish catches were no longer a filler to tide over periods of scarcity. The only solution appeared to be an upward adjust-

[1] Submitted for publication, August, 1944.

ment of the OPA rockfish ceiling. No one suspected that flatfish gear could be used to ease the shortage of rockfish.

Use of a trawl, or "drag net," is an old method for catching bottom fishes such as the halibuts, flounders, soles, and turbots. Nearly 75 years ago (1870) the San Francisco fishermen started using a Mediterranean type of net called "paranzella," which was dragged along the bottom by two lateen-rigged sailboats. This primitive method of trawling still operates in the State, except that the sail has given way to diesel engines; but the net has been little changed. During recent years an improved type of drag net has been used, the otter trawl, so-called because the mouth of the net is held open by two "otter boards," hung so that they tend to diverge; and in spreading, they hold open the entrance to the net. The greatest advantage is that but one boat does the dragging, instead of the two boats required by the paranzella net. The old type paranzella was a heavy net of complex construction, with a heavily weighted lead line, or foot rope. The newer otter trawls were simpler in construction, usually of lighter materials, but still carrying the weighted lead line so that the net would scrape the ocean floor in order to pick up the flatfishes from the bottom. The bulk of the catch from either type of net was flatfish; but in certain localities, incidental hauls of sharks, crabs, and sablefish were made. Rockfishes were taken occasionally on certain grounds, but the catches were never large, and were accidental rather than intentional.

Beginning in November, 1943, a net specially designed for catching rockfish was tried out at Eureka, and from the start it proved to be very successful. This net, nick-named the "balloon trawl," is said to have been originated on our Atlantic coast and later introduced into Washington and Oregon. At any rate, a trawler, newly arrived in Eureka from Astoria, was the first to use this net locally. In January of 1944, a second boat from Newport, Oregon, used the net; and soon was joined by a third trawler purchased in Seattle. Within a few months more than a dozen Eureka trawlers were fishing successfully a balloon-type of net for rockfish. The resulting catches were filleted by women, in the absence of available men, and these catches were shipped immediately to fresh fish markets.

The captain of the first vessel to use the balloon net in Eureka has a theory that both the paranzella and otter board nets, being designed for flatfish, tend to dig into the ocean bottom, thereby stirring up a cloud of mud, or ooze. This alarms the rockfish so that they rise sufficiently to avoid the net. He attributes the success of the balloon net to the fact that it is of lighter construction, does not dig in, and fishes much higher off the bottom than either of the older drag nets. This mud-cloud theory is reasonable, but as yet lacks evidence, for or against.

The balloon net in its overall dimensions is much like the otter trawls now in use along our coast. The funnel-shaped net is no larger, and the spread of the wings is no greater; but it differs from the older nets in several important respects. When fishing, the vertical opening at the mouth of the net is about twice as high, its lead line or foot rope is not weighted, the over-hang or distance of the corkline in advance of the lead line at the mouth of the net is greater, and the whole net is of very simple and light construction, as compared with the flatfish drag nets. The balloon net uses the same mesh size throughout. Since it

skims lightly over the bottom, there is no need for any chafing gear or heavier webbing on the bottom of the net. The light-weight net can be handled by a crew of two men, and the rockfish drags are usually of but one-hour duration. In recent years, the warps, or tow lines, of many drag nets have been woven wire steel cable instead of the heavy manila rope that was standard equipment in the past. The balloon net trawlers carry about 275 fathoms of one-half-inch wire cable on two powered drums, one warp to each otter board. Rockfish trawling at Eureka is now carried on 6 to 10 miles off-shore at depths of 60 to 80 fathoms. The same balloon trawls are sometimes dragged at greater depths (even down to 125 fathoms) for sablefish, and at times are used for shark fishing.

The balloon nets now in use at Eureka are about 75 feet long, measured with the meshes open, and including the wings. Most of the nets are made throughout with four and one-quarter inch mesh (stretched measure), but a few are four and one-half inch. Overall measurements of a typical four and one-quarter inch net are:

Wings,	100 meshes	long, about	25 feet.
Body,	100 meshes	long, about	25 feet.
Intermediate piece,	50 meshes	long, about	12½ feet.
Cod end,	50 meshes	long, about	12½ feet.

The principal portion of the net, the body, is cut so that there is a pronounced taper aft when the piece is hung. The webbing of the shorter intermediate piece is not cut to a taper, but its hanging take-up provides a taper when fishing. The same is true of the heavier cod end. The intermediate piece and the cod end together constitute the sack. The body piece forms the mouth, or throat to the sack, and with its wings, forms the funnel-shaped lead-in to the sack. The wings and body are made from webbing of 27 thread, medium laid twine, and the intermediate piece is of 42 or 48 thread. The cod end is usually 96 thread. Naturally, there are variations from the typical net, one such being made up of light 24 and 36 thread webbing in the wings and body, with no intermediate piece but instead an extra long and heavy cod end to serve as sack.

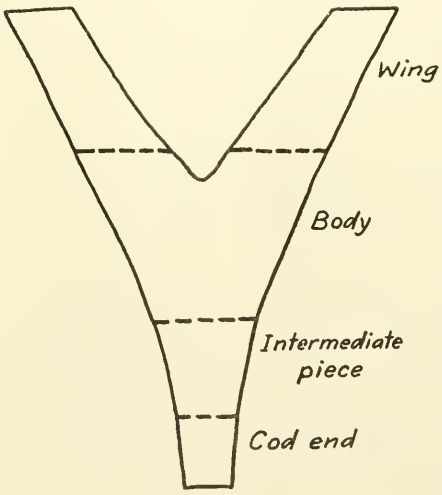

FIG. 8. Sketch of a balloon trawl (not to scale) to show pieces of webbing used in construction.

The distinctive feature of the balloon net is the hanging of the body piece so that, in fishing, the cork line "balloons" up from the lead line with a vertical opening at the mouth of 20 or even 25 feet. The ordinary otter trawl has a mouth opening of 8 or 15 feet, and the paranzella probably fished with an opening of not more than 6 or 8 feet. The body piece of the balloon net is cut away for the lead line so the cork line

overhangs or fishes several feet in advance of the lead line. In lesser degree, this overhang is true of both the paranzella and ordinary otter trawl. The typical balloon trawl uses a heavy manila foot rope wrapped with a lighter line to protect against abrasion, but it carries no lead weights, although some of the nets have added a little lead, especially along the wings. The weight of the webbing and foot rope between the heavy otter boards sinks the net sufficiently for it to skim the bottom without digging into it. It is necessary to have the cork line well buoyed so as to get the full benefit of the ballooning construction. This is accomplished by using 7 to 12 glass balls. The common 5- and 6-inch balls are considered too small; and the 8-, 9-, and even 12-inch balls are preferred. Usually a large glass buoy is attached in the center over the mouth, with 6 to 12 smaller balls spaced along the cork line. Hollow iron balls are preferred because of greater buoyancy and less breakage, but metal is not obtainable at present.

Trawls usually have a fyke or trap of some sort to prevent fast-swimming fish from leaving the net after they have once entered the sack. For flatfishes, the forward end of such a fyke was frequently attached to the floor of the net, and the after-end suspended a couple of feet above the floor to discourage flounders from trying to escape. The balloon nets employ a simple curtain of webbing, the forward edge of which is attached to the top, or roof, of the intermediate piece. It slants downward and aft about 12 feet to within a foot or so of the floor of the sack. The after-edge hangs free, allowing rockfish to enter readily, but blocking their escape. The lower edge of this curtain has a rope selvage to prevent wear. This curtain fyke is known locally in Eureka as a "cod catcher."

There is considerable strain on the webbing in trawl nets from dragging a heavy catch in the cod end; so reinforcing ropes are run fore and aft from the lead and cork lines to the cod end. The balloon nets have four to six "rib lines" of one-half inch rope to lessen the strain on the net. The opening at the extreme after-end of the sack is, in nearly all trawls, rigged with small purse rings, and held by a purse line secured by a "hangman's knot," so that the catch can be emptied on deck when the net is lifted aboard. Heavy catches can not be lifted without injury to the net, so many trawls have a laced opening along the top of the sack so that part of the catch can be brailed aboard before an attempt is made to lift the sack. Some of the balloon trawlers use a belt or "splitting strap" around the cod end to divide the catch in the net, and allow hoisting part of the load aboard by use of the boom while the remainder of the catch is left floating in the net. The emptied portion of the cod end is then returned to the water, and the catch is again separated by the splitting strap. Sometimes three or four lifts are made before a heavy catch is aboard. This is considered faster than brailing through a laced opening in the sack, although many boats prefer the older method.

Trawl nets are inevitably subjected to heavy wear, and frequent damage from rocks on the bottom, so the boat must carry one or two spare nets on a trip. Much time ashore is spent mending nets; but trawlers are not so careful about tanning as are gill netters, for example. Perhaps this is due to the short life of trawl nets, and the likelihood that they will wear out before they rot from lack of frequent tanning. The balloon trawlers prefer tan bark, although some nets are treated with copper oleate.

HIPPOBOSCID FLIES AS PARASITES OF GAME ANIMALS IN CALIFORNIA [1]

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Bureau of Game Conservation
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Certain flat flies, classified as Hippoboscidae, live on birds and mammals by sucking the blood of their hosts. These flies, unique in many ways, are very abundant on some game species, particularly deer and quail.

Many who observe these flies on deer refer to them as ticks. They could more logically be called "tick flies," although the commonly used "louse fly" seems to be more descriptive. They are soft bodied as compared with true ticks and are characteristically flattened dorso-ventrally; that is, they have flat bodies similar to an unfed tick or louse. They may or may not have wings. Those which occur on deer and antelope are sluggish in their movements, while those which occur on birds move rapidly, with equal facility forward, backward, or sideways. These flies do not feed on man.

Louse flies are blood suckers and as such are potential carriers of disease (of which more later). They can live only a few days away from their normal hosts and apparently must obtain frequent blood meals in order to maintain their existence. In most flies, such as the house fly, for example, the female lays a great many eggs. The eggs hatch into larvae, or maggots, which are actively motile, worm-like creatures. These maggots then develop into pupae, each pupa being enclosed in a hardened case, the pupal case or puparium, and in this stage of development, which may last from a few weeks to several months, the organism is quiescent. The adult fly finally emerges from the pupal case as a winged adult.

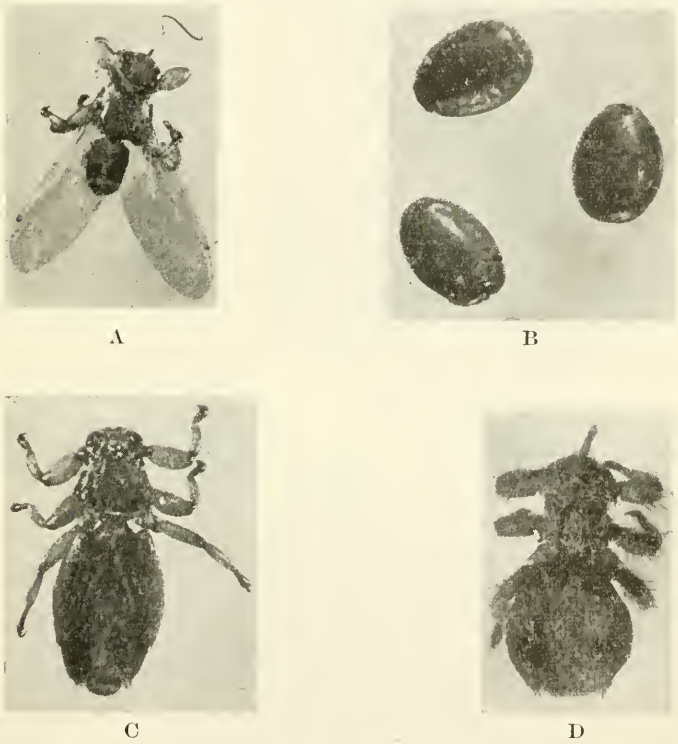
The hippoboscid, or louse flies, have a much modified life cycle. They produce only one offspring at a time. Both the egg stage and the larval or maggot stage run their course within the female fly, and just as the larval stage is being completed the puparium is deposited by the parent. This is a characteristic of the group of insects known as Pupipara, to which the louse flies belong. The pupal case is an ebony black, oval, hard, seed-like body which rarely adheres to the fur or feathers of the host. The pupae may fall off the host anywhere, but are naturally most abundant in nests or bedding places. The period of development before the louse fly emerges from the pupal case is known to vary considerably, but otherwise very little is known of the length of life.

Louse Flies of Deer

The louse flies which commonly occur on ruminants are most frequently referred to as ked flies. A detailed account of the anatomy, host, and geographical distribution of the ked flies appears in a monograph by Bequaert (1942).

[1] Submitted for publication, October, 1944.

Two species of ked flies commonly occur on deer in California, *Lipoptena depressa* and *Neolipoptena ferrisi*. They are very similar in size, shape, and general appearance and can be differentiated only after careful study and under magnification. The pupal cases (B, Fig. 9) are black, seedlike bodies, and the flies, when they emerge, break through an opening in the cap of the puparium. One of the pupal cases illustrated is empty and the slit through which the fly escaped can be seen quite readily. From our observations in the laboratory the pupal develop-



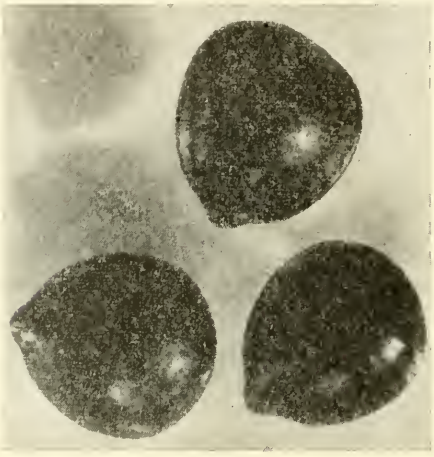
A B C D

FIG. 9. Photographs of louse flies of mammals. All magnifications to same scale, approximately X 12. A, newly emerged adult *Neolipoptena ferrisi* from deer; B, pupal cases of *N. ferrisi;* C, fully grown adult *N. ferrisi;* D, adult *Melophagus ovinus* from sheep.

ment may take from six weeks to as long as six months. Cowan (1943), in studies conducted similarly to ours on southern Vancouver Island, British Columbia, observed the elapsed time for the pupal period to vary from 43 to 214 days. When the flies emerge from the pupal case they are winged (A, Fig. 9) and are smaller than the adults (C, Fig. 9). Within a few days the delicate, brittle wings break off leaving only short stumps. At maturity they are slightly larger than on emergence.

Cowan has made much more extensive observations on these flies than we have in our laboratory. He has observed that while most of the puparia are black, many may be in a white phase when deposited. However, in from 6 to 14 hours these larvae become the characteristic hard,

black, oval body described above. In a few cases (premature larvae) these bodies assume a brown, rather than black color. Cowan estimates the longevity of these flies to be between a maximum of 13 months and a minimum of eight months, the latter being the more probable figure. His evidence suggests that the gestation period is approximately two



A

B

C

FIG. 10. Photographs of louse flies from quail. Magnifications approximately X 12. A, pupal cases of *Stilbometopa impressa*, B, adult *Lynchia hirsuta;* C, adult *S. impressa.*

months. Thus, if pregnancies succeed one another with maximum rapidity, each female may produce from 4 to 7 larvae during her life span.

Deer frequently are very heavily infested with these flies. Cowan has observed deer with as many as an average of two individuals per square inch of body surface indicating an estimated population of 2,000 to 2,400 flies on one animal. On one doe from Sequoia National Park,

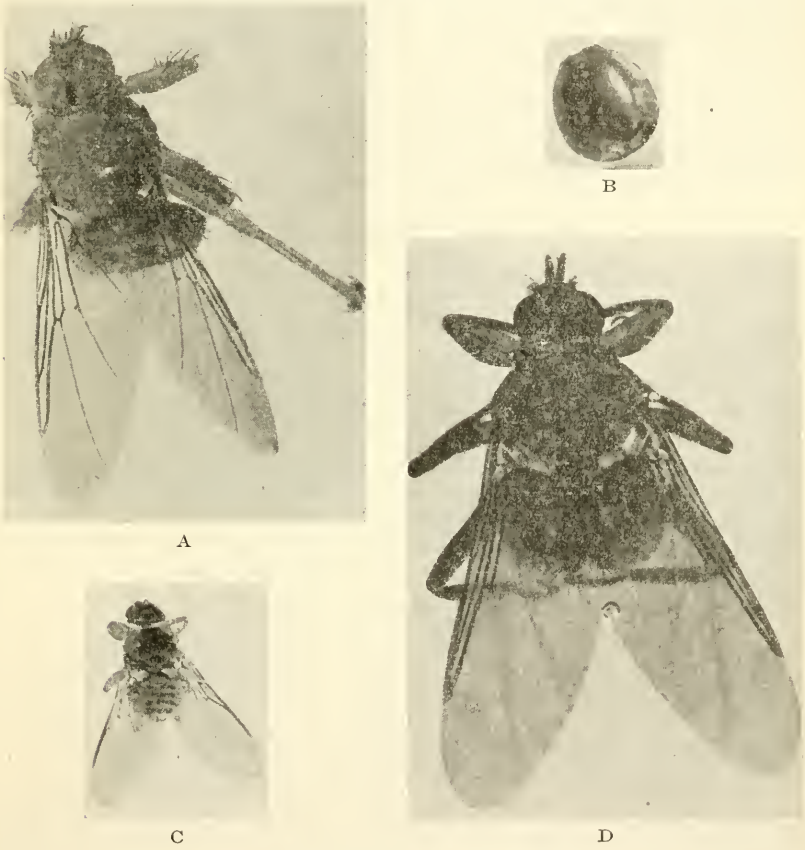


FIG. 11. Photographs of louse flies from birds. Magnifications approximately X 12. A, adult *Ornithomyia anchineuria* from song sparrow; B, pupal case of *O. anchineuria;* C, adult *Ornithoica confluenta* from redwing; D, adult *Lynchia fusca* from great-horned owl.

Dixon and Herman (1945) by actual count reported 1,350 flies. Heavier infestations have been observed and doubtless deer often carry even more than 2,400 individual flies. Frequently, particularly in heavier infestations, the flies may be observed in chains, one attached to another. We have seen as many as seven flies in such a chain. It is probable that in heavy infestations the flies remove much blood from the deer and it has been suggested that the loss of blood, in some cases, is sufficient to cause anemia and resultant poor condition of the host.

In view of the fact that the species of hippoboscid flies which occur on deer remain primarily on one animal throughout their life span, it

might be expected that their role in the transmission of blood-borne diseases would be at most only a minor one. This seems to be the case. In this regard it should be stated that the closely related ked fly, *Melophagus ovinus* (D, Fig. 9), of sheep, which is wingless throughout its life, transmits a nonpathogenic trypanosome (blood parasite) disease. Although the ked flies of deer could be expected to transmit such blood parasites in a similar manner, as yet no trypanosomes have been observed in the blood of deer. Numerous unsuccessful attempts have been made with sheep keds to transmit other diseases, some of which may occur in deer.

The flies themselves may also suffer from diseases. Sheep keds frequently harbor various parasites and other microörganisms, the significance of which has not been determined, and recently Steinhaus (1943) reported a bacterial infection of the deer fly *Lipoptena depressa*.

Louse Flies of Prong-horn Antelope

There have been no reports, to our knowledge, of louse flies on our native species of antelope. During the antelope hunting season in 1943, we obtained a winged specimen of *Neolipoptena ferrisi* from an antelope at the Ravendale checking station. Since the deer season already had begun and deer previously had been checked at the same spot, this occurrence was considered accidental. Early in the 1944 hunting season we examined an antelope at the Susanville checking station which had two of these flies firmly attached (wings already broken off), one feeding on the upper lip, the other on the eyelid. However, the prong-horn antelope in California is relatively free of ectoparasites, and there have been no reports of the heavy infestations of these flies, or of true ticks, fleas, or lice such as are frequently encountered on deer.

Louse Flies of Birds

The hippoboscid flies of birds are winged throughout their adult life and are all easily flushed from their host. With the ability to get about readily from one individual bird to another, they have much greater potentialities as disease transmitters than the wingless flies of deer and antelope discussed above, or than true ticks or lice.

Of the louse flies which occur on wild birds, those on quail seem to have the greatest potential importance from an economic standpoint. Two species occur commonly, *Lynchia hirsuta* and *Stilbometopa impressa*. Both are winged throughout their adult life. O'Roke (1928, 1930, 1932), during his studies in 1927, 1928, and 1929, found the smaller fly, *L. hirsuta*, to be much more common on the California valley quail than *S. impressa*. Our observations during 1941, 1942, and 1943, showed the reverse to be true. Although our surveys and the data which have been available to us have been much more extensive than O'Roke's original limited studies, it nevertheless appears that the incidence of these two flies on our native quail has changed markedly during the interim of a decade and a half.

Lynchia hirsuta (B, Fig. 10), originally described by Ferris (1927), has been taken only on quail in California. Nothing is known of its life history. O'Roke observed a pair of these flies in copula on October 5th. He observed three individual females deposit pupae immediately after

being taken from quail and placed these in vials on July 7th, August 2d, and October 5th, respectively. A fly emerged from the second of these after 31 days. A single pupa which we obtained in August, 1941, produced a fly after 47 days. O'Roke was unable to keep a fly alive away from the quail for more than five days, and we have had the same experience. These flies are delicate and their welfare is intimately related to their host from which they not only suck blood for food, but on which they are also dependent for warmth. They have pincher-like feet which enable them to hold fast to the feathers of their hosts and their flat bodies enable them to glide easily under the feathers. They can move with great rapidity, are swift fliers, and usually leave the bird almost immediately after it is shot. If one handles a live bird and ruffles the feathers, the flies dart out but often will fly back onto the bird. Heavy infestations have not been observed. The greatest number on a single quail reported by O'Roke is four flies.

Lynchia hirsuta was shown by O'Roke (1930) to be the transmitting host of *Haemoproteus lophortyx,* a blood parasite which causes malaria in quail. This infection was reported by O'Roke in valley quail from several areas in California, and by Herman and Glading (1942) from valley quail in the San Joaquin Valley. Our own data as yet unpublished, collected from blood smears during the past few years, show it to be prevalent in many areas in California, frequently in more than 80 per cent of the birds sampled from any given region.

Stilbometopa impressa (C, Fig. 10) is a louse fly which has been taken only on quail in California. It is much larger than *L. hirsuta* and not quite as rapid in its movements. This fly also tends to leave the quail as soon as the bird is shot and is easily flushed when a live bird is handled. As many as ten of these flies have been collected from a single quail. They are common on quail in some coveys, and at the same time in the same general area the flies may be absent on other coveys.

In previously reported studies (Herman, 1944) we have noted that puparia may be white when deposited or may be in the final black stage (A, Fig. 10). The white, seed-like bodies changed color through shades of orange and red until they had become the characteristic shining black. These color changes may take as long as 16 hours. The flies emerge from the pupal case in from 29 to 162 days. The interval required for the pupal stage increases as winter advances but not in any definite progression. Injury to the pupal case before the black phase is reached may prevent emergence of the fly, but moisture seems to have no ill effect.

S. impressa can be kept alive off the bird host for only five days. The normal life expectancy of an individual fly is not known. When opportunity presents itself the quail will eat the louse flies.

It is probable the *S. impressa* also acts as a transmitting agent of *Haemoproteus lophortyx* malaria. We have seen stages of a parasite (probably *Haemoproteus*) on the midgut of at least two of these flies, but the complete life cycle has not been demonstrated. We also have observed an unidentified flagellate (trypanosome parasite) in the intestinal tract of the flies. It has not been determined whether this is a parasite of the flies or a stage of a trypanosome from the blood of quail. We have seen trypanosomes (*Trypanosoma avium*) in blood smears from valley quail (*Lophortyx californica vallicola*) and it is possible that louse flies could serve as the transmitting agent of these parasites.

Pseudolynchia canariensis, the common louse fly of domestic pigeons, was the first hippoboscid fly to be demonstrated as the transmitting agent of a parasitic disease. It transmits the *Haemoproteus* malaria of pigeons. Both the disease and the flies are common in many part of the United States but constitute a serious problem chiefly in the southeastern States. It has been reported from southern California by Kadner (1941). *Microlynchia pusilla* is also capable of transmitting *Haemoproteus* from pigeon to pigeon.

Wood and Herman (1943) have reported *Haemoproteus* infections in our native band-tailed pigeon, western mourning dove, and western white-winged dove. This malaria has been reported from many parts of the eastern States from the eastern mourning dove. *Microlynchia pusilla,* a small louse fly winged throughout its adult life, is the only common species which occurs on our wild doves. It has been reported chiefly from the southern part of the country, including Texas, Arizona, and California. The author has seen a female specimen of this species taken from a western mourning dove (*Zenaidura macroura marginella*) by G. F. Augustson at Brawley, California, on April 7, 1940. In view of the fact that this fly has been demonstrated experimentally to be capable of transmitting *Haemoproteus* malaria in domestic pigeons, it is probably the vector of the wild dove infection. Bequaert (1939) has pointed out that this is the only common fly which occurs in any numbers on doves, although several other species have been reported. We have seen no flies on doves from northern California. Several workers have reported *Haemoproteus* malaria in young, eastern mourning doves on the breeding areas in the northern tier of the United States, but the louse flies are extremely rare. In an examination of over 100 doves in Massachusetts during the summer of 1937, only a few flies of a species common on sparrows, thrushes, etc.—apparently accidental on doves—were found. Much more study is needed to explain the incidence of *Haemoproteus* malaria in young doves in view of the scarcity of the louse fly vectors.

We have found *Haemoproteus* parasites in blood samples from sprig (*Dafila acuta tzitzihoa*) and it has been reported from several species of ducks in the eastern States. There are no published records or specimens of louse flies from any North American species of ducks, although we have had several verbal reports that they do occur. It would add greatly to our knowledge of malaria and louse fly relationships if some of these flies could be obtained for study.

Owls and hawks in California are usually infected with *Lynchia fusca* (D, Fig. 11). As many as 18 of these large louse flies have been collected from a single great-horned owl from Lassen County. We had an opportunity to study the interval of development of seven pupae of this fly which were deposited by captive flies on August 6, 1943. In every case the flies emerged on September 24, 1943 (49 days). Owls and hawks also suffer from a *Haemoproteus* malaria, and, in California, *L. fusca* is probably the transmitting agent. Herms and Kadner (1937) in laboratory experiments have shown that this fly is capable of transmitting the *Haemoproteus* malaria of quail.

For the sake of comparison, and because many of the small birds become infected with *Haemoproteus* malaria, a brief mention should be made of the louse flies which occur on sparrows, thrushes, and other song birds. Two species are common, *Ornithomyia anchineuria* (A, Fig. 11)

and *Ornithoica confluenta* (C, Fig. 11). As with the other bird louse flies already discussed, these are winged throughout their adult existence. Herman (1937.2) has reported that these flies are likely to be more abundant on the younger birds. In Massachusetts as many as 19 *O. confluenta* were collected from a single redwing blackbird and as many as 23 *O. anchineuria* were taken from a cowbird at one time. The biology, length of life, and host relationships of these flies are not known. They have been taken from many birds in California. On occasion they may also occur on hawks and owls which prey on the smaller birds. They are probably involved in the transmission of *Haemoproteus* malaria of their hosts.

Parasites of Bird Louse Flies

A number of investigators have suggested that louse flies may serve to disseminate other ectoparasites among the birds. Several cases have been reported of hippoboscids with Mallophaga (feather lice) attached to their abdomen. In one case the author has examined young cowbirds taken from a chickadee's nest. The cowbird nestlings were infested with louse flies. One of these flies had two lice attached to its abdomen (Herman, 1937.1).

Bird louse flies sometimes are infected with small mites of the sub-family Myialgesinae. All species of this sub-family which have been reported occur only on hippoboscid flies. Nothing is known of their life history. Ferris (1928) pointed out that the mites leave a scar when removed from a fly. It is possible that these mites may be one of nature's controls on the abundance of these flies. Ferris reported the mites on

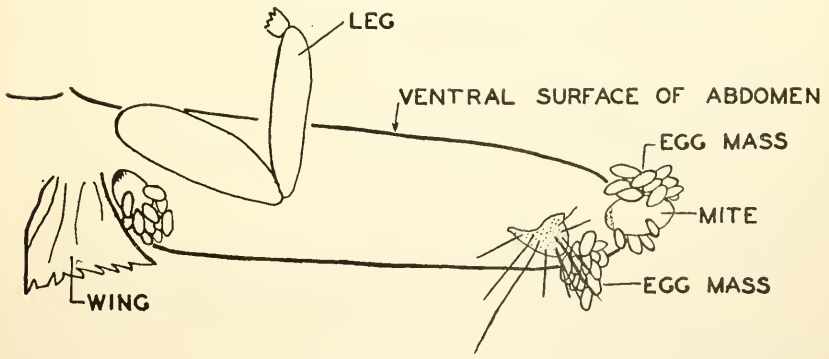


FIG. 12. Diagrammatic sketch of *L. fusca* infested with parasitic mites. Lateral view.

Ornithoica confluenta from California. We have seen them on one of 11 specimens of *Lynchia hirsuta* from valley quail; on specimens of the pigeon fly, *Pseudolynchia canariensis,* in the collection of G. F. Augustson; and on numerous specimens of *Lynchia fusca* from both hawks and owls. In one case 11 *L. fusca* taken from a great-horned owl were all infested, while the flies which emerged from seven pupae deposited by these same infested owl flies were free of mites. These mites (Fig. 12) are very minute, and usually attach themselves to the under surface of the abdomen at the posterior end of the body and under the wings.

Usually only females are found, each with a large egg mass surrounding it. In examination of several hundred specimens of *Stilbometopa impressa*, the large quail fly, we have seen no mites. Could this be the reason for the apparent increase in numbers of *S. impressa* and decrease in the density of population of *L. hirsuta?* As indicated in our discussion of these flies, it seems evident that a change in the prevalence of these two species has occurred, whatever the cause may have been.

Acknowledgments

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EDITORIALS AND NOTES

ORIGIN AND NATURE OF AN UNUSUAL RED PIGMENTATION IN CANNED MACKEREL

In the latter part of September, 1944, in the course of the routine inspection of canned mackerel, an unusual red pigmentation was observed. This red color was most concentrated at the top of the liquid contents of the cans, but in some cases the meat itself also had a conspicuous red color. This unusual condition caused some concern because it had been shown in the important investigations of H. Sommer, K. Meyer, and others (Relation of Paralytic Shellfish Poison to Certain Plankton Organisms of the genus *Goniaulax,* Archiv. of Pathology, vol. 24, pp. 537-559. 1937) that the appearance of the so-called "red water" and a mussel poisoning effect are usually related. As far as we know, toxicity in mackerel has never been observed but it was nevertheless possible in this case that the red color might indicate a toxic infestation of the canned fish. We tried, therefore, to determine whether the red colored fish had any toxic properties, and furthermore, what the origin and nature of the red color itself might be.

By inspecting the whole fresh fish we easily located the red pigment in its highest concentration in the alimentary tract. Therefore, we collected the intestines and livers of the suspected fish and cominuted them in the Waring Blendor with acidified methanol, according to the method published by Meyer, Sommer, and collaborators. After evaporation of the alcohol extract, the residue was dissolved in water and the aqueous solution was fed to or injected into mice. Neither injection nor feeding in relatively exorbitant quantities (150 mg. of the residue per 20 grams mouse weight) affected the animals at all. They behaved normally and did not show any pathological changes. *Therefore, the assumption that the red color might be associated with some poisonous material was eliminated.* (Dr. H. Sommer confirmed this observation.)

There was little doubt that the red color had an alimentary origin. In order to identify the red pigment, we extracted it from the intestinal paste with methanol in form of a bright red solution. The material could be distributed between aqueous methanol and petroleum ether, the latter acquiring a brilliant yellow color. In addition we determined with the Beckmann spectrophotometer the spectral absorption curve of the pigment in petroleum ether (b.p. 60°-71° C.) between wave-lengths 350 mu and 550 mu. This revealed only a single absorption maximum with 473 mu. The behavior of the pigment in organic solvents and its absorption maximum suggests that the coloring material is identical with the carotenoid of acid character called astacin. Astacin was thoroughly investigated by Kuhn and Lederer, and in the United States by D. L. Fox and B. T. Scheer (Comparative Studies of the Pigments of Some Pacific Coast Enchinoderms. Biol. Bull. LXXX [3] pp. 441-445. 1941.) This compound which is responsible for the red color of the boiled lobster is

widely distributed among marine organisms and is found even in some whose color is not red. It was shown by the mentioned authors that in Crustacea the precursor of this pigment "astaxanthin" is originally present in association with a colorless protein in the form of a greenish-blue or grayish chromoproteid. Boiling of the animal denatures the protein component and liberates the carotenoid in the form of the well-known red colored "astacin." However, digestion of the chromoproteid could also be responsible for the appearance of the red color.

It was impossible to identify the organisms in the intestinal contents of the mackerel, and therefore to decide whether a red food was ingested or the red color developed only during the digestion. The few intestinal remnants seemed to indicate that the pigment originates from ingested Crustacea. It is interesting to note that the red pigment was present only in the intestines of the "Horse Mackerel" (*Trachurus symmetricus*), and not in those of the "Pacific Mackerel" (*Pneumatophorus diego*) even when these two varieties were caught together in a mixed school.—*E. Geiger and G. Schnakenberg, Van Camp Laboratories, Terminal Island, California, October, 1944.*

TWENTY-FIVE YEARS AGO IN CALIFORNIA FISH AND GAME

Of the six papers which make up the 15 pages of the main body of California Fish and Game for January, 1920, (the remainder of the 44 pages being devoted to editorials, notes and reports), one of the shortest is by far the most significant. This is "The Proposed Investigation of the Sardine" by Will F. Thompson.

At that time Dr. Thompson, only nine years out of college and not yet a PhD., was listed in this bulletin simply as an Assistant in the Department of Commercial Fisheries (now our Bureau of Marine Fisheries), as was also a young man named Elmer Higgins. Together they were the principal components of the California State Fisheries Laboratory; and the Laboratory, which had originally been two rooms in the Thompson home, was a rented building. The sardine investigation, as may be judged by the title of Thompson's paper, was barely beyond the program stage. And the sardine yielded an annual catch in California of 150,000,000 pounds.

Since then, Will F. Thompson has become internationally known as the Director of the International Fisheries Commission (dealing with the Pacific Halibut) and of the International Pacific Salmon Fisheries Commission. Elmer Higgins has risen to be Chief of the Division of Fisheries Biology of the United States Fish and Wildlife Service. The California State Fisheries Laboratory now owns its own buildings. The sardine investigation has become a major project of agencies of both the State of California and the United States. And the sardine fishery—of which Thompson said "It is well nigh impossible that this giant industry * * * should continue to grow at the rate it has in the past, but an increase is still surely to be expected"—produced in 1943 a catch of 972,000,000 pounds.

In contrast to all this progress and growth, two of the editorials have to do with projects which ended in failure. Under the title "New Game Fish Imported" it is recorded that a shipment of ayu eggs was received from Japan by the California Fish and Game Commission in November

of 1919. The ayu is described as a sporting fish of the trout family reaching a length of 8½ inches, expected to make an excellent fish for the anglers. Upon arrival at the Brookdale Hatchery, the editorial relates, the eggs were apparently all dead, but since the Commission was very anxious to give the experiment a thorough test every precaution was taken in the handling and placing of them in the hatchery troughs in case any life should develop. This hope appears to have been vain, for the ayu is never heard of again.

"California Furnishes Striped Bass to Hawaiian Islands" relates that on November 15, 1919, the Commission shipped about 2,500 of these fish, from 2½ to 5 inches long, on the *SS Maui*. Supplied with circulating salt water during the voyage, they arrived at their destination with little loss, and were presumably planted in waters near Honolulu, but nothing has been heard of them since.—*Brian Curtis, Editor, California Fish and Game.*

RETIREMENT OF E. H. OBER

After 36 years of service with the Division of Fish and Game, E. H. Ober retired October 1, 1944, having reached the age of 70 years.

Ober was appointed a deputy September 15, 1908 and was promoted to captain in 1927. For the past few years he was on special duty in the Los Angeles office, acting as public relations officer with sportsmen's clubs and other service organizations in southern California.

Ober was considered an authority on mountain sheep, and published an article, "The Mountain Sheep of California," in the January 1931 issue of this magazine. He was also one of the persons instrumental in the first transplanting of golden trout from their original habitat in the Mt. Whitney area to other parts of the high Sierra.

Our best wishes go to Captain Ober for a long and happy retirement. —*L. F. Chappell, Chief, Bureau of Patrol, California Division of Fish and Game, November, 1944.*

IN MEMORIAM

RAY DIAMOND

Ray Diamond, fish and game warden, died at his home in Crescent City August 4, 1944. Death resulted from a heart attack while he was asleep.

Warden Diamond was appointed to the Bureau of Patrol August 1, 1927, and served in the northern part of the State during most of the time.

He is survived by a wife and children to whom we express our deepest sympathies.—*L. F. Chappell, Chief, Bureau of Patrol, California Division of Fish and Game, November, 1944.*

WEBB TOMS

Webb Toms, retired from the Division of Fish and Game since 1932, died of a heart attack October 21, 1944, on the street in San Diego.

Webb was appointed a fish and game deputy July 8, 1909, and was stationed in San Diego County throughout his years of service with the Division.

He was 81 years of age at the time of his death.—*L. F. Chappell, Chief, Bureau of Patrol, California Division of Fish and Game, November, 1944.*

ALEX CHAPPIEU

Alex Chappieu, a former employee of the Division of Fish and Game who retired in 1934, passed away quite suddenly at his home in Mt. Shasta on October 31, 1944. He was 74 years old. He joined the staff in February 1920, and throughout his career worked for the Bureau of Fish Conservation at the Mt. Shasta and Klamath River stations.—*A. E. Burghduff, Supervisor of Fish Hatcheries, Bureau of Fish Conservation, California Division of Fish and Game, November, 1944.*

REPORTS

FISH CASES

July, August, September, 1944

Offense	Number arrests	Fines imposed	Jail sentences (days)
Abalones: overlimit, undersize, no license	33	$1,080 00	
Angling: more than two attractor blades, closed stream, closed area, fishing 150 feet of dam, using minnows for bait not native, failure to show license on demand, taking young bluegills to be used for bait, placing explosives in water to take fish	106	2,700 00	1
Barracuda: overlimit	1	50 00	
Bass, striped: using two poles, undersize, no license	30	574 00	
Clams: undersize, in refuge	17	525 00	25
Commercial: selling undersize halibut, possess white sea bass aboard boat carrying purse seine, selling salt water perch closed season, using purse seine net to take fish district 20, using set gill net District 15, using gill net larger than 1¾ inch mesh District 2½, selling spotfin croaker	29	1,725 00	
Crabs: undersize female	1	50 00	
Lobsters: closed season	5	195 00	
Pollution	1	150 00	
Salmon: night fishing, no license, taking between sunset and sunrise, snag hooks, overlimit, undersize, spearing	11	227 50	
Sunfish: using more than one pole	2	35 00	
Taking invertebrate specimen from refuge	1	5 00	
Trout: overlimit, no license, more than one pole	20	485 00	
Totals	257	$7,801 50	26

GAME CASES

July, August, September, 1944

Offense	Number arrests	Fines imposed	Jail sentences (days)
Deer: closed season, hunting in refuge, firearms in refuge, using artificial light at night, no license, no deer tags, carry tags of another while hunting, shooting from vehicle, night hunting, spike buck, transfer tag to deer killed by another, using deer tags of another, failure to retain hide and horns, transporting deer without validation, female, spotted fawn, forked horn deer in District 1¾	129	$9,852 50	6 months
Deer meat: closed season	7	625 00	
Doves: closed season, unplugged gun, overlimit	54	1,745 00	
Ducks: closed season	10	350 00	
Hunting: refuse hunters with license permits to hunt on game management area, did not file monthly report as required, charge fee for hunting pheasant with no commercial club license, failure to show license on demand, no license	9	340 00	
Pheasants: closed season, hen, no license, shooting from vehicle	32	2,800 00	
Quail: closed season	2	55 00	
Rabbits: no license	11	250 00	12½
Sagehens: refuge, overlimit	3	125 00	
Shorebirds	1	25 00	
Squirrel, grey	1	25 00	
Taking fur bearing mammals for profit, no license	1	50 00	
Trapping non-game birds	1	25 00	
Totals	261	$16,267 50	12½ 6 months

SEIZURES OF FISH AND GAME

July, August, September, 1944

Fish:

Abalones	405
Bass, black	4
Bass, striped	21
Clams	245
Clams, Cockles	462
Clams, Pismo	19
Halibut, California, pounds	70
Lobsters, pounds	1,000
Lobster traps	6
Salmon, Chinook	21
Salmon, King	1
Sunfish	69
Trout	385
Trout, Rainbow	1,269

Game:

Deer	37
Deer meat, pounds	125
Deer meat, canned quarts	10
Doves	387
Ducks	17
Ducks, Teal	2
Killdeer	1
Pheasants	31
Pheasants, hen	27
Pheasants, male	11
Quail	1
Quail, valley	13
Rabbits, cottontail	14
Sagehens	4

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(Continued from inside front cover)

BUREAU OF ENGINEERING

JOHN SPENCER, Chief—San Francisco
Clarence Elliger, Assistant Hydraulic Engineer—San Francisco
Samuel Kabakov, Junior Civil Engineer—San Francisco

BUREAU OF LICENSES

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L. O'Leary, Supervising License Agent—Sacramento
R. Nickerson, Supervising License Agent—Los Angeles
Lorraine Atwood, License Agent—San Francisco

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D. H. BLOOD, Departmental Accounting Officer—Sacramento

BUREAU OF PATROL

E. L. MACAULAY, Chief of Patrol (absent on military leave)—San Francisco
L. F. CHAPPELL, Chief of Patrol—San Francisco

CENTRAL DISTRICT (Headquarters, Sacramento)

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Jos. H. Sanders, Captain—Sacramento
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E. O. Wraith, Captain—Chico
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Taylor London, Warden, Colusa County—Colusa
Albert Sears, Warden, El Dorado County—Placerville
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E. J. Johnson, Warden, Plumas County—Quincy
Charles Sibeck, Warden, Sacramento County—Sacramento
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T. J. Smith, Warden—San Diego
Carmi Savage, Warden—Santa Monica
R. C. Schoen, Warden—Terminal Island

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Cruiser *Rainbow III*, Antioch
Cruiser *Shasta*, Redding
Launch *Shrapnel*, Suisun
Launch *Minnow*, San Rafael

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